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ROLE OF NUCLEAR TESTING

Paul S. Brown

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Lawrence
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Nuclear Weapon R&D and the Role of Nuclear Testing*

Paul S. Brown
Lawrence Livermore National Laboratory

There have been increasing pressures for more restrictive limits on nuclear testing, including a comprehensive test ban. There is a widespread perception that nuclear testing fuels the arms race. Because of this perception, more restrictive test limitations can have political advantages, primarily by allaying the fears that people and nations have about the threat of nuclear war. In assessing these advantages, one must, however, recognize that our national policy with respect to nuclear weapons is one of deterrence. The U.S. must maintain an effective, survivable, and varied nuclear force to convince any adversary that we could retaliate with nuclear weapons in the event of aggression against us or our allies. Restrictive test limitations impose serious technical costs which would threaten the credibility of our nuclear deterrent and could result in severe political costs.

There are four fundamental reasons why we do nuclear tests⁽¹⁾: 1) to maintain confidence in the existing stockpile, 2) to modernize the stockpile for improved safety, security, survivability, and military effectiveness, 3) to assess the vulnerability of weapons to the nuclear threat environment posed by the weapons of our adversaries, and 4) to avoid technological surprise by maintaining the scientific judgment necessary to understand the limits of weapon potential.

Stockpile Reliability

The weapons in the stockpile and currently under development have been conservatively designed to avoid as best possible the adverse effects of aging within the constraints of the military requirements. Scientists and engineers strive to make their designs durable and robust against foreseeable stockpile conditions. Nuclear weapons, however, are complex mechanisms made of highly reactive materials and sometimes, of necessity, they include materials with limited lifetimes. Because of these characteristics, changes have occurred in stockpile weapons that raised the question of whether a weapon would perform as designed. Most often, scientists have been able to assess and fix these problems without nuclear tests, using technical judgment based on years of experience in nuclear design and tests, which permitted them to evaluate crucial factors.

Nuclear tests, however, have been necessary to fix problems. Approximately one-third of all modern weapon designs placed in the U.S. stockpile required and

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received postdeployment nuclear tests for resolution of problems. In three-fourths of these cases, the problems were discovered only because of the ongoing nuclear testing.

While many problems occurred in earlier systems, a number are relatively recent. In one case, deterioration of a weapon component required a design modification and a nuclear test to certify that the new design would perform properly. In a second case, a final proof test of a stockpiled weapon, tested under aging conditions to be expected in the stockpile, gave an unexpected reduction in yield, necessitating a design change and an additional test. In a third case, a final test of a weapon at its specified low-temperature extreme resulted in only a small fraction of the expected yield, necessitating a design change and another proof test.

Stockpile Modernization

The global strategic balance is constantly changing. New technologies and developments can weaken the credibility and survivability of the U.S. deterrent; they may also enhance credibility and survivability. The tension between these two effects leads to a dynamic deterrent relationship among nations. In turn, this can lead to changes in mission requirements for our nuclear forces or to changes in delivery systems, which might require the modification of existing nuclear warheads or the development of new warheads.

For example, the survivability of our land-based missile force is now threatened by accurate Soviet missiles with high yields. A small mobile intercontinental ballistic missile (SICBM), sometimes called the Midgetman, has been suggested to increase the survivability of our land-based forces. There is a debate as to its size and whether it should carry a single or multiple warheads. The choice of a warhead for the SICBM awaits resolution of this debate, and nuclear testing will be necessary to develop that warhead.

The safety and security record of the U.S. stockpile is excellent. However, only one-third of our stockpile weapons have the desired modern safety and security features. No weapon accident has ever produced nuclear yield, although accidents have occurred where the high explosive (HE) in the weapons detonated, dispersing plutonium. This success is due, in large part, to our continuing efforts to modernize the stockpile by incorporating new safety and security features into new and existing weapons. We have recently implemented insensitive HE (IHE) which is extremely difficult to detonate in an accident such as an airplane crash. Continued nuclear testing is required to fully include IHE in the stockpile.

It is often said that modernization has led to increasing yield and numbers of weapons. In fact, the opposite is true. The total yield of the U.S. stockpile has been reduced fourfold from its peak value in the mid-1960s. This reduction is

largely the result of increased accuracy of delivery systems, which has made it possible to develop and deploy warheads of lower yield. The number of U.S. nuclear weapons in the stockpile is now about 25% lower than the peak value in the mid-1960s.

Nuclear Effects Testing

Nuclear testing is necessary to test the effects of nuclear weapons on a vast array of military equipment. Of particular concern are the nonnuclear components of our strategic weapon systems, warning sensors, and communications equipment which might have to function in a nuclear environment. Often, nuclear effects tests on such equipment reveal changes that must be made, and additional nuclear tests usually are required to certify the survival and proper functioning of these systems in a hostile nuclear environment.

Maintenance of Scientific Judgment

Ultimately, the viability of our nuclear deterrent rests on the judgments of our nuclear scientists. They must judge what technological developments by our adversaries might threaten that viability. Also, future stockpile problems will inevitably occur and requirements for new weapons will arise. Weapon scientists cannot address the impact of new technologies, verify that a problem has been properly fixed, or certify that a new weapon design will meet its military requirements on the basis of nonnuclear experiments alone. Nor can they model with computers all the complex physical processes necessary to predict warhead performance with confidence.

Assessment of weapon performance rests on scientific judgment based on nuclear test experience. This judgment takes considerable time to develop, is cultivated by the application of theory and experiment to device design, and is continually refined on the basis of data from nuclear tests. Removing the confirmation provided by tests would result in the overextension of judgment and in the reduced credibility of the nation's deterrent. This was indeed the case from 1958-1961 when the U.S. and U.S.S.R. observed a moratorium on nuclear tests. The U.S. experienced a number of surprises when certain weapons developed during the moratorium failed to perform as predicted when they were finally tested.

1. "Nuclear Weapon R&D and the Role of Nuclear Testing," Energy & Technology Review, Lawrence Livermore National Laboratory, Livermore, CA, Sept., 1986.